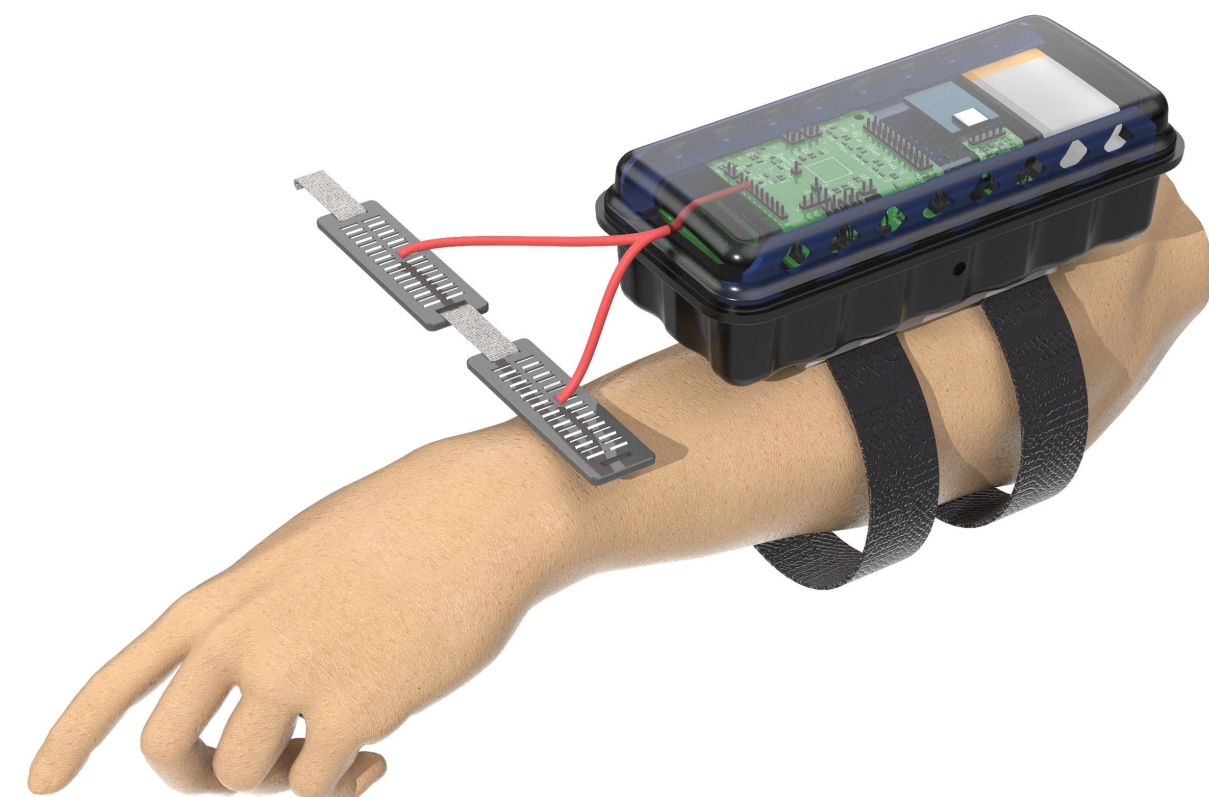


Background & Problem

- 36.9% of surveyed youth **skiers** and snowboarders reported listening to music while skiing or snowboarding [2]
 - Phones are difficult to access beneath layers of clothing while skiing
 - Gloves and ski poles make **touch and button controls difficult** to use
 - Wind, helmets, and face coverings can reduce the practicality of voice control
- ⇒ Current media control methods are poorly suited to the physical and environmental conditions of skiing

Proposed Solution

A wristband that uses forearm sEMG to recognize hand gestures and send them to a phone over BLE. Usable while wearing gloves and holding ski poles



Constraints & Requirements

- Recognize intentional gestures while wearing gloves and holding ski poles
- Minimize false activations and missed commands
- Convert recognized gestures into wireless media commands
- Provide at least 5 hours of portable battery operation

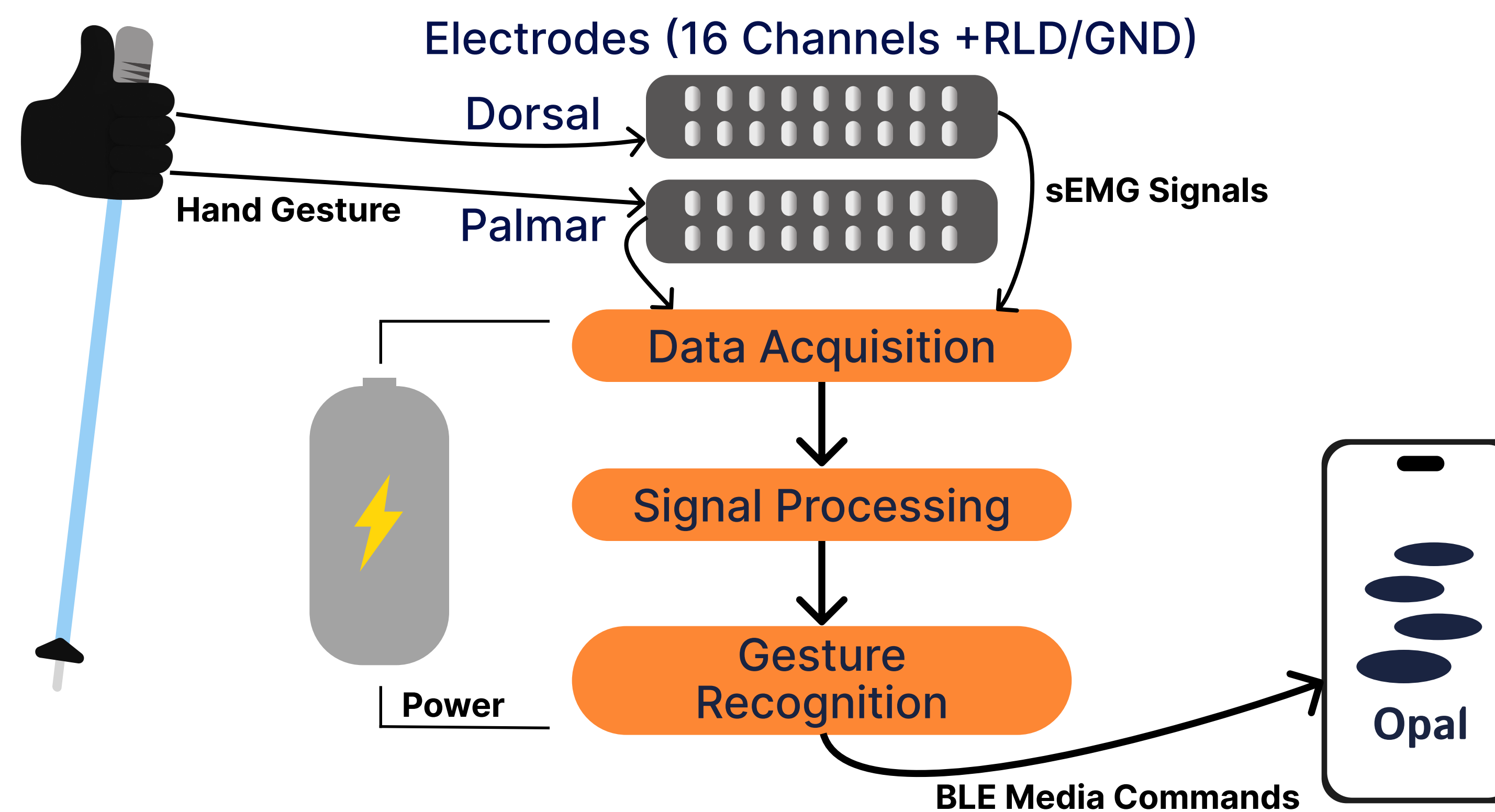
Environmental Constraints

- Cold alpine temperatures
- Exposure to snow and water

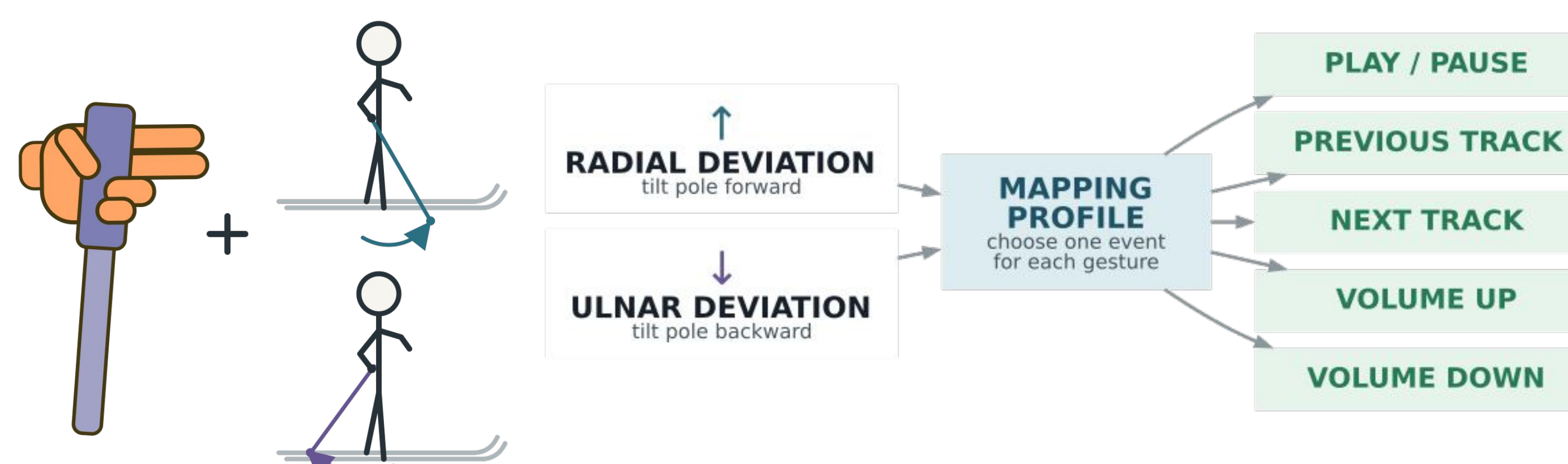
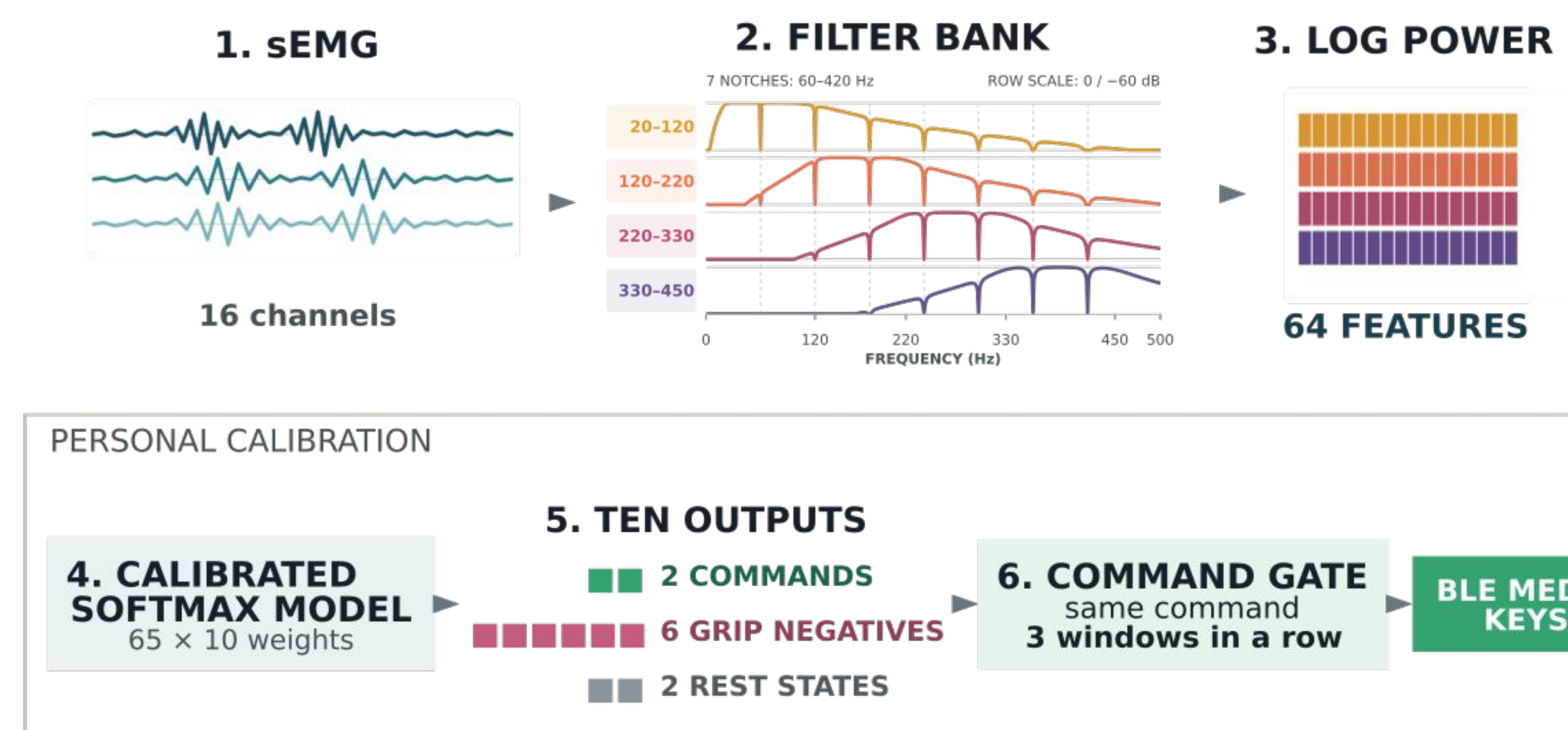
User Constraints

- Variation in muscle signals and anatomy
- Motion, pole gripping, and wristband shift during skiing

System Overview



Gesture Pipeline



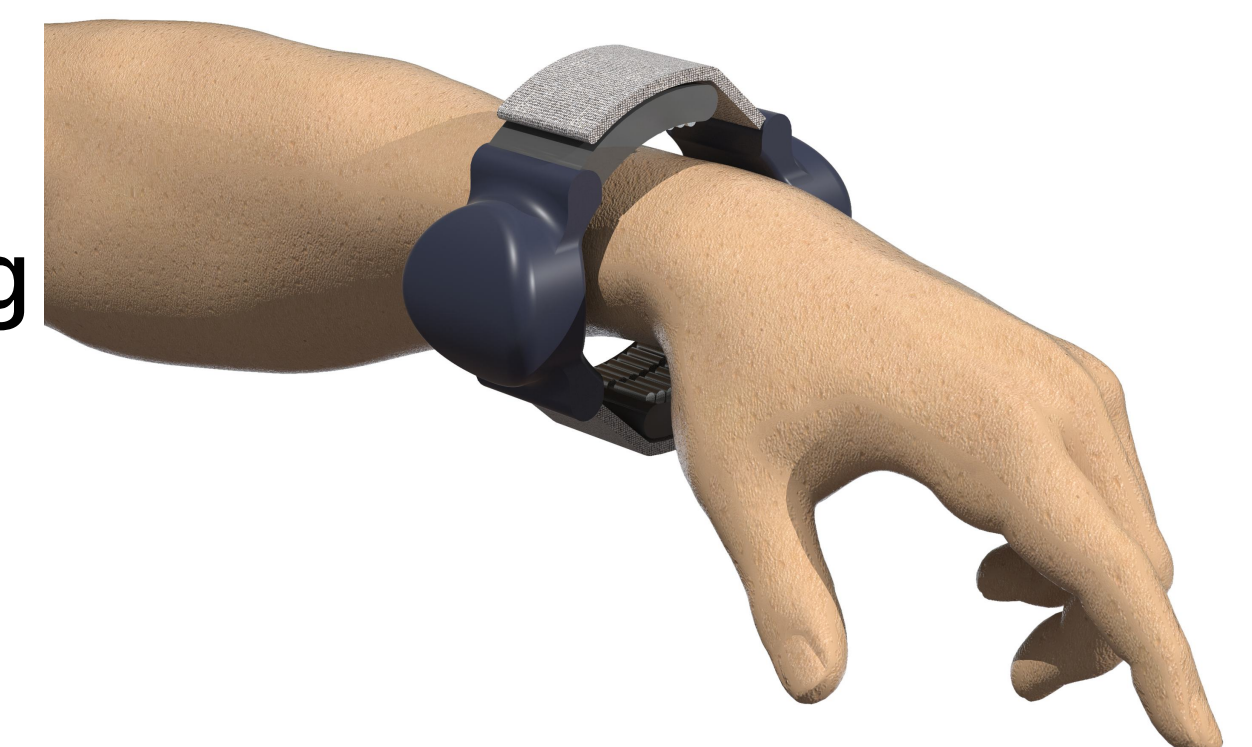
Testing & Results

COMMAND CONFUSION				CALIBRATION	
90 calibration rows per command				52 cues / 468 rows	
				one wearer / one don	
TRUE \ PREDICTED	RADIAL	ULNAR	NO COMMAND	ON-DEVICE COMPUTE	
RADIAL	86	1	3		
ULNAR	0	87	3	59.1 ms / 250 ms	
				24% of the time budget	

- Device calibrated per don (so per user). Trained on device.
- Allows high accuracy by avoiding generalization pitfall common to sEMG.
- Operation under realistic skiing conditions has not yet been validated
- Poor electrode contact and placement due to arm hair and wristband shifting degrades sEMG signal quality
- Recognition performance can vary between users, requiring user-specific calibration

Future Work

- Miniaturizing the device into a compact wristband
- Improving reliability under realistic skiing conditions
- Expanding the training dataset across more users



Conclusion

Opal demonstrates that forearm sEMG can be used to control music playback through hand gestures while wearing gloves and holding ski poles

References

- [1] A. Dulyan, "Opal veins," Wikimedia Commons, Feb. 18, 2005. [Online]. Available: https://commons.wikimedia.org/wiki/File:Opal_veins.jpg. [Accessed: Aug. 10, 2026].
[2] K. Russell, S. Arthur, C. Goulet, E. Selci, and B. Morrongiello, "Understanding youths' attitudes and practices regarding listening to music, video recording and terrain park use while skiing and snowboarding," BMC Pediatrics, vol. 20, art. no. 389, Aug. 2020, doi: 10.1186/s12887-020-02292-6.